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Hence the value of the reversion to £68,275·5 Stock expectant on the death of the last survivor is £45,190 stock; or £38,411·5 sterling, if we again take stock at 85, since it is now a question as to the selling price. Lastly, the share of X, ($\frac{1}{20}$th + $\frac{1}{7}$ of $\frac{1}{20}$th) will be of the value £2195.

It must be borne in mind that the share of X is probably subject to legacy or succession duty; and that a double duty is probably payable on the $\frac{1}{7}$th of the $\frac{1}{20}$th share. Nor must it be lost sight of that accumulation for more than 21 years after the death of a testator is illegal. Altogether, we may conclude that unless the legacy duty is very heavy, the reversion might be expected to sell for about £2000.

INSTITUTE OF ACTUARIES.

SOLUTIONS OF THE SECOND YEAR'S EXAMINATION QUESTIONS.

(Continued from vol. xiii., p. 260.)

Questions for 1864.

1. Find an expression for the Napierian logarithm of any number in terms of the logarithm of the preceding number; and by the aid of such expression find $\log_{10}2$ to five decimal places.

2. To what base is $-1{\cdot}765776$ the log. of 1,000? Given reciprocal of $1{\cdot}765776 = {\cdot}566323$.

Ans. Base $= \dfrac{1}{50}$.

3. Find the probability of turning up 1, 2, 5, in any order, in three successive throws of a die. Explain the principles assumed in the solution of the question.

Ans. $\dfrac{1}{36}$.

4. A and B play together as follows:—A throws a coin and continues to throw as long as he throws head. If this happen four times, he wins; if not, he resigns the coin to B on the same terms, B to resign it again if he should fail, and so on. The first who throws four heads in succession wins one shilling. Find the values of the expectations of A and B.

Ans. $\dfrac{64}{127}$ and $\dfrac{63}{127}$.

5. Find the relation between the discount of any sum payable n years hence, and the present value of an annuity for the same term of years. Distinguish between the discount here referred to and commercial discount, as well as discount at simple interest.

Ans. If D be the discount, A the annuity, $A = \dfrac{D}{i}$.

6. Construct a specimen table of the present value of an annuity, at 3 per cent. interest, of £1 for 25, 26, &c., years, to 30 years. Given $v^{30} = {\cdot}4120$.

7. Give some account of the Carlisle table of mortality. What is to be remarked as to the relative proportion of the sexes among the lives on

which it was based? How does that affect the use of the table for the purposes of a Life Office?

Ans. The Carlisle Table of Mortality was constructed by Milne from observations made by Dr. Heysham, giving, in intervals of age, the population of two parishes in that city in January 1780 and December 1787, and also the deaths in the same parishes in the nine years 1779–87.

The population enumerated in 1780 was 7677, whereof 3491 were males and 4186 females. The relative proportions, 45 per cent of males, and 55 per cent of females, show an unusual preponderance of the latter sex. Now we know from other observations that the mortality is more favourable at the older ages among females than males. If therefore, as is sometimes contended, the Carlisle Table fairly represents the mortality likely to prevail in any English community, it follows that in Life Offices, where the proportion of males to females is about 10 to 1, this table will understate the mortality likely to be experienced at the advanced periods of life.

8. What are the two different modes by which the law of mortality of a population has been ascertained?

9. The function p_x being tabulated, show how to construct from it a table of the mean duration of life.

Ans. $e_x = \frac{1}{2} + p_x + p_x p_{x+1} + p_x p_{x+1} p_{x+2} + \ldots$ or $e_x = \frac{1}{2} + p_x(\frac{1}{2} + e_{x+1})$.

10. Let P represent the population of a country at a given period, $\frac{1}{a}$ the proportion of deaths in a year, and $\frac{1}{b}$ the proportion of births in a year; find the population at the end of n years, assuming that no emigration or immigration takes place.

Ex.—Given the death rate 1 in 25, birth rate 1 in 20, in about how many years will a population double itself?

Ans. (1) $P\left(1 - \frac{1}{a} + \frac{1}{b}\right)^n$. (2) About 70.

11. Describe briefly commutation tables, and explain the mode of constructing Column D for joint lives.

12. Prove the formula $M_x = vN_{x-1} - N_x$.

13. Distinguish between "probable lifetime" and "mean after-lifetime," as defined by Dr. Farr; and state upon what hypothesis they are identical.

14. Why is not the value of an annuity on the life of a person of a given age equal to the value of an annuity certain for the term of years representing the mean duration of life at that age?

Vide De Morgan's "Budget of Paradoxes," *Journal of the Institute*, vol. xii., pp. 32, 33; Jones on *Annuities*, vol. i., pp. 122, 123.

15. If B = present value of a benefit of £1 upon a given life (x),

B_1 = do. do. do. ($x+1$),

p = the probability of a payment of B being received in the first year, and

Π = the probability of x surviving the year,

Prove that $B = v\Pi\left(\frac{p}{\Pi} + B_1\right)$.

16. Show how to apply the equation in the last question to the construction of a table of the value of a reversion of £1 on decease of a single life.

Ans. $A_x = vp_x\left\{\frac{1-p_x}{p_x} + A_{x+1}\right\}$.

17. An annuity on the longest of three lives, A, B, and C, is to be enjoyed by A for his life; after his decease it is to be divided equally between B and C during their joint lives, and the survivor of them is to have the whole. Find an expression for the value of B's interest.

18. Prove that the single and annual premiums for an endowment assurance are respectively $1-(1-v)(1+a_{m_{\overline{t-1}|}})$ and $\frac{1}{1+a_{m_{\overline{t-1}|}}}-(1-v)$.

19. Obtain an expression for the value of a life annuity in terms of the annual premium. Explain the modification of the formula when the premium is increased by a loading.

Ans. $\varpi_x = \frac{1}{1+a_x} - d \quad \therefore\ a_x = \frac{1}{\varpi_x + d} - 1$.

If the premium be increased by a loading, ϖ_x will represent the Office premium, and a_x the value of an annuity on an isolated life aged x, such as to yield a purchaser interest at a rate corresponding to d, and enable him also to secure the return of his capital by a Life Assurance.

20. Find the single premium for an assurance for n years of £1 on the failure of a life aged (x), provided that another aged (y) survive him.

Ans. ${}_{\overline{n}|}A^{1}_{\overline{xy}} = \frac{1}{2}\left\{{}_{\overline{n}|}A_{xy} + \frac{{}_{\overline{n}|}a_{x-1.y}}{p_{x-1}} - \frac{{}_{\overline{n}|}a_{x.y-1}}{p_{y-1}}\right\}$.

21. Deduce an expression for the annual premium for a deferred annuity, with return of all the premiums in the event of death occurring before the annuity is entered upon.

22. If a_x be the value of an annuity of £1 payable annually on a life aged (x), prove that the value of the annuity payable half-yearly is $a_x + \frac{1}{4}$ very nearly.

23. An assurance for the whole of life, at the ordinary premium, has been in force for n years. It is proposed to commute the future premiums for an annual premium payable for m years only. How is this to be calculated?

Ans. The premium required $= \frac{N_{x+n-1}}{N_{x+n-1} - N_{x+n+m-1}} \times P_x$.

24. A copyhold estate is held on three lives aged respectively 61, 50, and 45, each renewable at the end of the year in which it drops by a life of 7 years of age on payment of a fine of £5. Give an expression for the present value of all the fines for ever.

Ans. $(A_{61} + A_{50} + A_{45})\frac{5}{1-A_7}$.

25. Under certain Acts of Parliament for the improvement of land, power is given to borrow money in consideration of an annual rent-charge for a term of years certain. In such a case, point out a method of finding, at the end of any year, the amount of capital outstanding; and also of apportioning the rent-charge in any year between the interest and capital accounts.

Ans. If n be the term of years, then at the end of m years the capital outstanding is $\frac{1}{i}\{1-v^{n-m}\}$, the annual rent-charge being 1. Also of the rent-charge received at the end of the mth year, v^{n-m+1} is capital and $1-v^{n-m+1}$ is interest.

QUESTIONS FOR 1865.

1. Explain what is meant by the common and by the Napierian logarithm of any number.

Write down the series giving their values, and deduce a series adapted for actual computation.

2. Explain how a complete table of common logarithms may be computed to any number of decimal places required.

3. Approximate to the value of $\log_{10}2$ by means of a continued fraction.

4. Show that the logarithms of all numbers may be found to any required number of decimal places by means of a table giving to the required number of places the logarithms of

$$N,\ 1+\cdot 1\times N,\ 1+\cdot 01\times N,\ 1+\cdot 001\times N,\ \ldots.$$

for values of N from 1 to 9. If n places of decimals are required, what will be the last of the above quantities which it will be necessary to tabulate?

5. If two events are independent of each other, and the chance of the first happening is p_1, and the chance of the second p_2; prove that the chance of their both happening is p_1p_2.

Find the chance of both failing; also the chance of one happening and the other failing.

Ans. (1) $(1-p_1)(1-p_2)$; (2) $p_1+p_2-2p_1p_2$.

6. Find the value of a sum of money to be received at the end of n years if a certain event happen of which the probability is p.

Ans. $p(1+i)^{-n}$, or pv^n.

7. Explain De Moivre's hypothesis.

Assuming the truth of that hypothesis, find the expectation of life at any age: prove that it is also the term which there is an even chance of surviving; and find at what age it is most probable a person of a given age will die.

Ans. (1) $l_x=86-x$; (2) $e_x=\frac{86-x}{2}$; (3) all ages are equally probable.

8. With which table of mortality does De Moivre's hypothesis best agree? In what respects do the tables generally in use differ from the hypothesis?

Ans. (1) The Northampton. (2) In the tables in general use, the decrements, instead of being constant, increase (after childhood) up to about the age 72, and then decrease.

9. If a mortality table were such that the numbers living formed a series in geometrical progression, what would be the nature of the tables giving the chance of dying in a year, and the expectation at any age?

Ans. The chance of dying in a year would be constant, or the same at all ages. (2) If $l_{x+1}=kl_x$, and $x+z$ be the extreme age in the table, then $e_x=\frac{1+k}{2(1-k)}-\frac{k^{z+1}}{1-k}$.

10. Describe Gompertz's theoretical law of mortality; and give his formula for the number living at any age.

Ans. $l_x=gd^{p^x}$.

How is this theory found to agree with observation?

Ans. Very closely, for a considerable number of years; but the same values of the constants will not apply throughout the table.

11. Prove the formula for an annuity on the last of three lives.

12. Explain how such an annuity is found in practice; and show that the rule is accurately true if the mortality agrees with Gompertz's hypothesis.

13. Find the single premium for an assurance on the life of x, provided he die during the life of y or within t years after the death of y.

Ans. $A_x-\frac{D_{x+t}}{D_x}(A_{x+t}-A^{\,1}_{\overline{x+t.y}})$.

Write down the formula for the annual premium on the same on the supposition (1) that the premium is payable for the joint lives only, (2) during the whole continuance of the assurance.

Ans. The divisor for (1) is $1+a_{xy}$. For (2), it is

$$1+a_x-\frac{D_{x+t}}{D_x}(a_{x+t}-a_{x+t.y}).$$

14. Find the value of an assurance on the life of x provided he die AFTER y.

For which of the two lives would the usual medical examination be required?

Ans. (1) $A^{\,2}_{\overline{xy}}=A_x-A^{\,1}_{\overline{xy}}$. (2) The life y is the one which should be examined; but if y be much older than x, then x should also be examined.

15. Explain the construction and use of the various columns in a D and N table for two joint lives, including the columns for the calculation of contingent assurances.

16. Prove the formula for the value of an annuity payable half yearly,

$$\frac{a_x}{4}\left(2+\sqrt{v}+\frac{1}{\sqrt{v}}\right)+\frac{\sqrt{v}}{4};$$

and show that the common approximation, $a_x+\frac{1}{4}$, agrees with the proceeding to two decimal places, but not in the third place.

17. A person wishes to effect an insurance for the whole term of his life, in such a way that during the joint lives of himself and a much older person he may pay the smallest possible premium. How can this be arranged without prejudice to the Office granting the assurance?

Ans. It may be arranged that during the joint lives he shall pay a premium somewhat larger than the survivorship premium; and at the death of the elder life be allowed to continue the insurance at the ordinary rate of premium corresponding to his then age, independently of his state of health.

18. Find the annual premium for an insurance, on the supposition that interest at a given rate is allowed yearly to the assured on all premiums paid.

Ans. $\frac{M_x}{N_{x-1}-j(S_x+R_x)}=\frac{M_x}{N_{x-1}-jvS_{x-1}}$. Mr. Gray (on p. 64 of this volume) reduces this expression to $\frac{M_x}{R_x}$; but he omits to notice that this is only true on the supposition that interest is allowed to the assured *at the same rate as that by which the premiums are computed.*

19. Prove that the premium for a short term insurance on two joint lives is not much less than the sum of the premiums for insurances on the two lives separately.

What inference would you draw from this circumstance as to the value of a policy on two joint lives?

Ans. That the value of a joint life policy which has been in force for a few years, is small, as compared with the value of a policy on a single life.

20. Prove the formula for the value of an insurance payable at the instant of death:—

$$\frac{iA_x}{\log_e(1+i)}.$$

Expand this expression in a series as far as terms containing i^3.

Ans. $A_x\left(1+\frac{i}{2}-\frac{i^2}{12}+\frac{i^3}{24}\right)$.

21. Show how to find the value of the next presentation to a living.

22. Describe the two benefits of which an endowment assurance is composed, and from the annual premiums for those benefits deduce that of the endowment assurance.

Ans. These are a temporary assurance and an endowment, and adding the annual premiums for these two insurances, we get the annual premium for an endowment assurance equal to $\frac{M_x-M_{x+n}}{N_{x-1}}+\frac{D_{x+n}}{N_{x-1}}$.

23. The value of an annuity of £1 on the life of x, to commence on the death of y, may be expressed by the series

$$\frac{d_yN_x+d_{y+1}N_{x+1}+d_{y+2}N_{x+2}+\ldots\ldots}{l_yD_x}.$$

Explain the reasoning on which this formula is placed; and show its identity with the usual formula

$$\frac{N_x}{D_x}-\frac{N_{xy}}{D_{xy}}.$$

What is the signification of the first n terms of the series?

24. If P_x denote the annual premium for a whole life insurance, ${}_{\overline{n}|}P_x$ the annual premium for a term insurance for n years, and $\Pi_{x|n}$ the annual premium for an endowment payable at the end of n years, then the value of a policy effected at the age x, which has been n years in force, may be expressed

$$V_{x|n}=\frac{P_x-{}_{\overline{n}|}P_x}{\Pi_{x|n}}.$$

Establish this formula by direct reasoning, and show that it coincides with the ordinary formula.

25. There are n counters, marked respectively a, b, c, d, e, ... placed in a bag, and drawn out one at a time. Find the chance that neither a nor b nor c will hold its usual place among the letters.

Ans. $\dfrac{n^3-6n^2+14n-13}{n(n-1)(n-2)}$.

Questions for 1866.

1. Prove that the logarithm of a product is equal to the sum of the logarithms of the factors. In the common system of logarithms, what is the effect (1) of adding 1 to the logarithm, (2) of moving the decimal point one place to the right?

Ans. (1) We get the logarithm of ten times the given number. (2) We get the logarithm of the tenth power of the number.

2. Supposing a and b to be two large numbers, whose difference is small, prove the following formula for the logarithm of the intermediate number:—

$$\log_e \frac{a+b}{2} = \frac{\log_e a+\log_e b}{2} + \frac{(a-b)^2}{(a+b)^2+4ab} + \frac{1}{3}\left\{\frac{(a-b)^2}{(a+b)^2+4ab}\right\}^3 + \ldots.$$

Adapt this formula to the common system of logarithms.

Ans. $$\log_{10}\frac{a+b}{2} = \frac{\log_{10}a+\log_{10}b}{2}$$
$$+\mathrm{M}\left[\frac{(a-b)^2}{(a+b)^2+4ab}+\frac{1}{3}\left\{\frac{a-b)^2}{(a+b)^2+4ab}\right\}^3+\ldots\right].$$

3. What is the probability that on an assigned Board day, the bank balance of an Insurance Company will be an exact number of pounds sterling?

What is the probability that the same will be the case at least once in the course of a year?

Ans. (1) $\dfrac{1}{240}$, (2) $1-\left(\dfrac{239}{240}\right)^{52}$.

4. There are two prizes in a lottery of 10,000 tickets. How many tickets must be taken to secure an even chance of obtaining a prize?

Ans. The number of tickets, x, is found from the equation $\dfrac{(n-x)(n-x-1)}{n(n-1)}=\dfrac{1}{2}$, and is equal to $n-\dfrac{1}{2}-\dfrac{1}{2}\sqrt{2n^2-2n+1}$; or $\left(n-\dfrac{1}{2}\right)\left(1-\dfrac{\sqrt{2}}{2}\right)$ approximately; or making $n=10,000$, $x=2929$.

5. Find the value of an annuity certain for n years, the first payment of which is to be made at the end of six months.

Ans. $\dfrac{\sqrt{1+i}}{i}\{1-(1+i)^{-n}\}$.

6. Describe the simplest practical method of computing a table of the present value of £1 due at the end of any number of years, at a given rate of interest.

7. Explain the method of forming a table of mortality from the death registers of a place, correcting for the increase of population.

8. Describe briefly the principles upon which a table of mortality is formed from the records of the transactions of a Life Insurance Company.

9. What are the principal mortality tables in use in England for life assurance purposes? and what are the chief arguments for and against the use of each?

Are the tables used for assurance calculations also suitable for the grant of annuities?

Ans. (1) "Northampton," "Carlisle," "Davies's Equitable," "Experience," "English Life." (2) Not generally, as it is important in the grant of annuities to distinguish between the sexes.

10. What is meant by the "expectation" or "mean duration" of a life of a given age?

Distinguish between this term, and the most probable duration of life; also the term which the life has an even chance of surviving.

11. Explain what is meant by the curtate expectation of two joint lives x and y. Prove that it is equal to

$$p_{xy,1}+p_{xy,2}+p_{xy,3}+\dots\dots$$

12. Express the following quantities in terms of the original elements (v, l_x, l_y, l_{x+1}, &c.):—

$$\mathrm{N}_x,\ \mathrm{M}_x,\ \mathrm{R}_x-\mathrm{R}_{x+n},\ \mathrm{M}_{\overset{1}{x}y};$$

and show that $\mathrm{M}_{\overset{1}{x}y}+\mathrm{M}_{x\overset{1}{y}}=\mathrm{M}_{xy}$.

Ans. $$\mathrm{N}_x=l_{x+1}v^{x+1}+l_{x+2}v^{x+2}+l_{x+3}v^{x+3}+\dots\dots+l_zv^z$$

$$\mathrm{M}_x=(l_x-l_{x+1})v^{x+1}+(l_{x+1}-l_{x+2})v^{x+2}+\dots+l_zv^{z+1}$$

$$\begin{aligned}\mathrm{R}_x-\mathrm{R}_{x+n}=&(l_x-l_{x+1})v^{x+1}+2(l_{x+1}-l_{x+2})v^{x+2}+3(l_{x+2}-l_{x+3})v^{x+3}+\dots\\&+(n-1)(l_{x+n-2}-l_{x+n-1})v^{x+n-1}\\&+n\{(l_{x+n-1}-l_{x+n})v^{x+n}+(l_{x+n}-l_{x+n+1})v^{x+n+1}+\dots+l_zv^{z+1}\}\end{aligned}$$

If $x-1>y$,

$$\begin{aligned}\mathrm{M}_{\overset{1}{x}y}=&\tfrac{1}{2}(l_x-l_{x+1})(l_y+l_{y+1})v^{x+1}+\tfrac{1}{2}(l_{x+1}-l_{x+2})(l_{y+1}+l_{y+2})v^{x+2}+\dots\dots\\&+\tfrac{1}{2}l_z(l_{z-x+y}+l_{z-x+y+1})v^{z+1}\end{aligned}$$

$$\begin{aligned}\mathrm{M}_{x\overset{1}{y}}=&\tfrac{1}{2}(l_y-l_{y+1})(l_x+l_{x+1})v^{x+1}+\tfrac{1}{2}(l_{y+1}-l_{y+2})(l_{x+1}+l_{x+2})v^{x+2}+\dots\dots\\&+\tfrac{1}{2}(l_{z-x+y}-l_{z-x+y+1})l_zv^{z+1}\end{aligned}$$

13. Prove the following equation:—

$$a_{x-m\,\overline{m}|}\mathrm{A}_{x-n\,\overline{n}|}=a_{x-n\,\overline{n}|}\mathrm{A}_{x-m\,\overline{m}|}.$$

Ans. Each side is equal to $\dfrac{\mathrm{N}_x\mathrm{M}_x}{\mathrm{D}_{x-m}\mathrm{D}_{x-n}}$.

14. Given the values of the single and annual premiums for the insurance of £1 on a life x, find the rate of interest.

Ans. $$i=\frac{1}{\dfrac{\mathrm{A}_x}{\mathrm{P}_x(1-\mathrm{A}_x)}-1}.$$

15. Prove that

$$\frac{a_x a_{x+1} \ldots . a_{x+n-1}}{(1+a_{x+1})(1+a_{x+2}) \ldots . (1+a_{x+n})} = p_{x,n} v^n .$$

16. If P_x be the annual premium for the insurance of £1 on a life x, show that the half-yearly premium is nearly equal to $\dfrac{\frac{1}{2}P_x}{1-\frac{1}{4}(P_x+d)}$.

17. Give formulæ for the value of an endowment payable

(1) If x survive n years.
(2) ,, both x and y survive n years.
(3) ,, either x or y survive n years.
(4) ,, x survive and y die within n years.

Ans. (1) $\dfrac{D_{x+n}}{D_x}$.

(2) $\dfrac{D_{x+n\,y+n}}{D_{xy}}$.

(3) $\dfrac{D_{x+n}}{D_x} + \dfrac{D_{y+n}}{D_y} - \dfrac{D_{x+n\,y+n}}{D_{xy}}$.

(4) $\dfrac{D_{x+n}}{D_x} - \dfrac{D_{x+n.y+n}}{D_{xy}}$.

18. Find the annual premium for a deferred annuity payable half-yearly; the first payment of the annuity being made six months after the payment of the last premium.

Ans. $\dfrac{N_{x+n}+\frac{1}{4}D_{x+n}}{N_{x-1}-N_{x+n}}$.

19. Find the value of a deferred annuity on the last of two lives.

Ans. $a_{\overline{xy}|n} = a_{x|n} + a_{y|n} - a_{xy|n}$.

20. Prove the formula for the annual premium for a temporary assurance, $v - \dfrac{N_x - N_{x+n}}{N_{x-1} - N_{x+n-1}}$.

21. Assuming that the deaths in each year of age are uniformly distributed, and supposing that two persons x and y both die in the same year, prove that the chance of x dying before y is accurately $\dfrac{1}{2}$.

22. Write down the three principal formulæ for finding the value of a policy.

Prove that the value is also equal to $1 - \dfrac{1-A_{x+n}}{1-A_x}$.

Ans.
$$\begin{aligned} V_{x|n} &= A_{x+n} - P_x(1+a_{x+n}) \\ &= (P_{x+n} - P_x)(1+a_{x+n}) \\ &= 1 - \frac{1+a_{x+n}}{1+a_x} . \end{aligned}$$

23. Find the annual premium for the insurance of £1 on a given life, with return of all the premiums paid.

Ans. $\dfrac{M_x}{N_{x-1}-R_x}$.

24. It is required to effect an insurance on a given life in such a way that after n annual payments the premium shall be reduced one-half, after $2n$ payments it shall again be reduced one-half, and after $3n$ payments shall cease; determine the premiums.

Ans. The premium for the first n years

$$=\frac{4\mathrm{M}_x}{4\mathrm{N}_{x-1}-2\mathrm{N}_{x+n-1}-\mathrm{N}_{x+2n-1}-\mathrm{N}_{x+3n-1}}.$$

25. If P_x denote the annual premium for an insurance on a life x, and ${}_{\overline{n}|}\mathrm{P}_x$ the annual premium for a temporary assurance of n years on the same life, prove that

$${}_{\overline{n}|}\mathrm{P}_x=\mathrm{P}_{x+n}-\frac{\mathrm{P}_{x+n}-\mathrm{P}_x}{1-(v-\mathrm{P}_x)(v-\mathrm{P}_{x+1})\ldots.(v-\mathrm{P}_{x+n-1})}.$$

NOTES AND QUERIES.

Professor Oppermann, of Copenhagen, sends us the following curious problem:—

If x_1 be formed from x_0 by the formula, $x_1=x_0^{\frac{1}{x_0-1}}$

and in general, $x_{n+1}=x_n^{\frac{1}{x_n-1}}$

what will be the limit of the process?

He states that for every value of x_0, real or imaginary, except 0 or 1, $x_\infty=2$.

CORRESPONDENCE.

SOLUTION OF PROBLEM PROPOSED BY PROFESSOR DE MORGAN.

To the Editor of the Assurance Magazine.

Sir,—In the October number of the Assurance Magazine, Professor De Morgan, referring to Surrender Values of the form $1-\frac{1+a_y}{1+a_x}$ or $\frac{a_x-a_y}{1+a_x}$, says:—

" Now a_x-a_y is the value to (x) of a counter-survivorship—as we " may call it—of the following kind. The executors of the first who dies " pay an annuity of £1 to the survivor; and $(a_x-a_y)\div(1+a_x)$ is the " whole life premium which (x) should pay to be put in this position. " How, from the nature of this contract, does it follow that one payment of " this premium, over and above the annual premium which (x) should pay, " admits (y) to a policy of £1 at the premium for the age (x)?"

The following appears to me to be the reason.

Since a_x-a_y is the value of a counter-survivorship annuity of £1, $\frac{a_x-a_y}{1+a_x}$ will equal the value of a similar annuity of $\frac{1}{1+a_x}$.